1. Scope

1.1 This procedure covers auditing of design features of lubrication systems for conformance to AGMA/AWEA 921-A97 and the procurement specification.

2. Referenced Documents

2.1 AGMA/AWEA 921-A97 Recommended Practices for Design and Specification of Gearboxes for Wind Turbine Generator Systems.

2.2 ISO/DIS 4406 (SAE J1165), Hydraulic Fluid Power- fluids- method for coding level of contamination by solids particles.

2.3 GEARTECH Specifications:

CK1000	QP1000	Procurement process
CK2000	QP2000	Procurement specification
CK3000	QP3000	Bid solicitation and evaluation
CK4000	QP4000	Gearbox design audit
CK4500	QP4500	Lubrication system design audit
CK5000	QP5000	Quality assessment
CK6000	QP6000	Quality assurance plan
CK7000	QP7000	Manufacturing schedule
CK8000	QP8000	Manufacturing audit

3. Terminology

3.1 Oil type- Refers to mineral or synthetic and additive system. See AGMA/AWEA 921-A97, Annex G.

3.2 Viscosity- Refers to ISO viscosity grade (ISO VG). See AGMA/AWEA 921-A97, Annex G.

3.3 Cleanliness- Refers to ISO cleanliness code (ISO/DIS 4406). See AGMA/AWEA 921-A97, Annex G.

3.4 Filtration ratio β- Efficiency of a filter to remove particles larger than a specified size. $\beta_{10} \geq 200$ indicates number of particles ≥ 10 μm upstream of filter divided by number of particles ≥ 10 μm downstream of filter. Efficiency equals $100(1 - 1/\beta)$. $\beta_x \geq 200$ indicates 99.5% efficiency for removing particles larger than "X" microns.

4. Significance and Use- The lubrication system design audit is necessary to ensure lubrication systems meet requirements of the procurement specification and have proven technology for the application.

5. Procedure

5.1 Checklist and quality procedures- CK1000 through CK4000 and QP1000 through QP4000 shall be used as guidelines for required data for lubrication system design audits. CK4500 shall be used as a guideline for lubrication system design audits. See CK5000 through CK8000 and QP5000 through QP8000 for guidelines for quality assurance.

5.2 Specification conformance- The lubrication system design documents including bill of materials, schematic, spare parts list, and maintenance manual shall be reviewed for conformance with AGMA/AWEA 921-A97 and the procurement specification.

5.3 Lubricant- Lubricant properties including type, viscosity, micropitting resistance, quantity, and cleanliness shall be reviewed for conformance with AGMA/AWEA 921-A97 and the procurement specification.

6. Interpretations of results

6.1 Specification conformance- Results of the lubrication system design audit shall be compared to requirements of AGMA/AWEA 921-A97 and the procurement specification for the following categories:

- Lubrication system features
- Lubricant properties
- Lubricant distribution
- Oil pump
- Filter
- Breather
- Plumbing
- Cooler
- Heater
- Gear housing
- Condition monitoring

7. Acceptance criteria

7.1 Lubrication system features- Lubrication system features shall meet the requirements of AGMA/AWEA 921-A97 and the procurement specification.

7.2 Lubricant properties- Lubricant properties including type, viscosity, micropitting resistance, quantity, and cleanliness shall meet the requirements of AGMA/AWEA 921-A97 and the procurement specification.

7.3 Lubricant distribution- All gears and bearings that do not dip in oil shall be pressure-fed.

7.4 Oil pump- The oil pump shall have adequate capacity to supply oil to all gears and bearings and maintain required pressures while operating at design speed.

7.5 Filter- Filters shall have filtration ratio at least as fine as $\beta_{10} \geq 200$. Filter element shall be spin-on. Bypass valve activation pressure shall be $\geq$ 3.5 bar. Pressure relief valve activation pressure shall be $\geq$ 3.5 bar. Filters shall be readily accessible for replacement.

7.6 Breather- The breather shall be a desiccant type with 3 μm dirt filter. It shall be located in a dry, non-pressurized area and shall direct contamination away from gears and bearings. Breathers shall be readily accessible for replacement.

7.7 Plumbing- All plumbing connections shall be welded or designed with reliable connectors. Pipe thread fittings shall not be used.

7.8 Cooler- The oil cooler shall have adequate capacity to maintain lubricant temperature ≤ 80° C while the gearbox is transmitting full power under hottest ambient temperature. A drain valve shall be provided to allow oil to be completely drained.

7.9 Heater- The heater shall have adequate capacity to increase lubricant temperature ≥ the pour point prior to startup under coldest ambient temperature. Thermostatic control shall be provided to avoid excessive heating. Heater rating shall not exceed 1.0 W/cm^2 of heater surface area.

7.10 Gear housing- Gear housing features shall meet requirements of AGMA/AWEA 921-A97 and the procurement specification. See CK4500 for housing design requirements.

7.11 Conditioning monitoring- Provisions for condition monitoring shall meet requirements of AGMA/AWEA 921-A97 and the procurement specification. See CK4500 for lubrication system design requirements.

8. Report

8.1 Report- The report shall include the following:

8.1.1 Summary of lubrication system features,

8.1.2 Summary of lubricant properties,

8.1.3 Summary of lubricant distribution,

8.1.4 Summary of oil pump,

8.1.5 Summary of filter,

8.1.6 Summary of breather,

8.1.7 Summary of plumbing,

8.1.8 Summary of cooler,

8.1.9 Summary of heater,

8.1.10 Summary of gear housing,

8.1.11 Summary of condition monitoring,

8.1.12 Recommendations for revisions to engineering specifications to ensure conformance to AGMA/AWEA 921-A97 and the procurement specification.